PATENT SPECIFICATION 1,105,029

DRAWINGS ATTACHED.

1,105,029

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COMPLETE SPECIFICATION.

Improvements in or relating to Methods and Apparatus for Drawing Synthetic Polymer Tapes and Products Thus Obtained.

We, SAINT FRERES, a Body Corporate organized under the laws of France, of Flixecourt (Somme), France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

It is usual to draw synthetic polymer sheets or tapes by heating the product at a temperature approximating its softening point between two roller units, the second unit having a higher peripheral velocity than the first unit and constituting the drawing roller unit. The ratio of the two peripheral velocities provides the drawing rate. The polymer is heated by means of an oven, a heated liquid bath or a heated plate.

The inconvenience characterizing these known methods is that the drawing operation thus performed in a single step is rather fierce and tends to take place at the ingress of the hot zone, at a point where the material has not had sufficient time to heat uniformly throughout its thickness; this may be a primary cause of rupture of the synthetic polymer film notably at this point, when the film has a relatively low initial thickness, for example of the order of 0.050 mm.

It is the object of the present invention to avoid this drawback. To this end, the present invention provides a method of drawing synthetic polymer tapes between a series of feed rollers and a series of withdrawal rollers driven at a peripheral velocity higher than that of said feed rollers, the ratio of the peripheral velocities of said feed and withdrawal rollers providing the overall drawing rate and a series of intermediate heating rollers mounted on fixed axes being provided between said feed rollers and said withdrawal rollers, characterized in that said tapes initially at room temperature are caused to pass over said intermediate heating rollers which are brought to a temperature below the softening point of the synthetic polymer to be drawn, up to not less than 10° C below this softening point in the case of polyolefines, and that said intermediate rollers are driven at a peripheral velocity increasing gradually from one roller to the next roller in the feed tape direction and lying between that of said feed rollers and that of said withdrawal rollers, the ratio of the peripheral velocities of any pair of adjacent intermediate rollers being selected to be lower than 2 : 1.

Each intermediate roller is adapted to perform a relatively moderate partial drawing action, and the tapes are gradually drawn, thus preventing breakages in the case of relatively thin tapes; under these conditions, very thin drawn tapes, of a thickness less than or equal to 0.40 mm, for example of the order of 0.015 mm, may be obtained in a reliable, economical and industrial manner. This method is particularly advantageous for drawing tapes of which the width to thickness ratio exceeds 50 : 1, and more particularly 150 : 1, a figure at which ruptures are frequently observed when applying conventional drawing methods. However, the method of this invention is equally applicable to the drawing of relatively thick tapes having a width-to-thickness ratio less than 50 : 1.

Besides, the gradual drawing of the tapes may be controlled by changing the number of

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said intermediate rollers and adjusting the speed ratio of the successive rollers. The greater the number of intermediate rollers and the lower the partial drawing rates, the more gradual the drawing effect. In the case of polyolefines, it is convenient to use at least five intermediate rollers.

The overall permissible drawing rate varies as a function of the nature of the synthetic polymers to be drawn. It is at least equal to the product of the partial drawing rates.

Among the synthetic polymers to which the present invention is applicable to advantage, polyolefines, polyamides, polyesters, and polyvinyl resins may be cited by way of example.

The manufacture of tapes, before the drawing operation has not any peculiar nature. Thus, for instance, an extruded film subsequently cut into longitudinal sections or strips may be used.

The aforesaid intermediate rollers are advantageously disposed in staggered relationship and the tapes are caused to follow between these rollers a zig-zag path increasing the contact area between the tapes and the rollers.

A preferred form of embodiment of the method of this invention consists in heating the intermediate rollers at a temperature increasing gradually from one roller to the next roller, so that the tapes are heated accordingly.

The rollers may be heated by means of internal electrical resistances, the circulation of a suitable heating fluid or any other suitable means. When a heating fluid circulation is used to this end, the rollers are gradually heated for example by feeding the fluid successively into the various intermediate rollers in countercurrent relationship to the direction of feed of the tapes. This gradual heating action in conjunction with the gradual drawing action makes it possible to discontinue the drawing operation and to resume same without any risk of breaking the tape, since no overheating takes place in the initial part of the drawing zone when the drawing machine is stopped, and on the other hand no sudden tractive efforts are applied to this critical zone when the machine is re-started.

The gradual drawing is also advantageous in that it permits of operating in the drawing zone as a whole at a temperature substantially lower than the synthetic polymer softening point, for example from 10 to 5° C below this point in the case of polyolefines.

This invention is also concerned with the drawing apparatus permitting of carrying out the method disclosed hereinabove.

Finally the present invention is concerned with the drawn tapes, markedly oriented in their longitudinal direction, obtained by applying the above-disclosed method, and notably very thin tapes of a thickness less than or equal to 0.040 mm and having a width to thickness ratio greater than 50 and, notably, above 150.

The characteristic features of these tapes, notably their dimensional characteristics, are such that they constitute very flexible articles lending themselves to a great number of applications in the textile industry, and in the string-making and rope-making industry. These tapes being extremely thin and having their stretch markedly oriented in the longitudinal direction tend to assume a fibre-like texture when used in practice on textile machines (looms, twisting machines, and the like), thus acquiring the same structural characteristics as multifibre roves of synthetic material (such as polyamide, polypropylene, etc.) commercially available now.

This invention will now be described in more detail with reference to the attached drawing of which the single figure illustrates diagrammatically a drawing machine specially designed for drawing polyolefine tapes such as low-pressure polyethylene tapes, polypropylenes and the copolymers of these substances.

An extruded polyolefine film 1 is fed to the nip of a pair of inlet drive rollers or feed rollers 2 and 3, and subsequently into a device 4 for cutting the film longitudinally into tapes 5.

These tapes subsequently follow a zig-zag path over a series of five intermediate heating rollers 6, 7, 8, 9 and 10 disposed in staggered relationship, and finally between two withdrawal rollers 11 and 12, whereafter the drawn tapes 13 are wound on spools 14.

The peripheral velocity of the pair of withdrawal feed rollers 11, 12 is greater than that of the feed rollers 2, 3, the ratio of these velocities giving the overall drawing rate applied to the tapes.

The intermediate heating rollers 6 to 10 are driven at peripheral speeds having values intermediate those of said pairs of feed rollers and withdrawal rollers, these intermediate roller velocities increasing from one intermediate roller to the next one, the ratio of the peripheral speeds of any pair of adjacent intermediate rollers being lower than 2 : 1.

These intermediate rollers are heated at a temperature slightly less than (by not more than 10 degrees centigrade in the case of polyolefine) the softening point of the synthetic polymer, the function of these rollers being to supply the heat necessary for performing the drawing process.

This apparatus comprises five successive drawing zones consisting of the successive sections extending between rollers 6 and 7, then 7 and 8, then 8 and 9, then 9 and 10, then 10 and 11, 12, the drawing rates obtained in these sections being respectively:

e_1, e_2, e_3, e_4, and e_5.

The overall drawing rate applied to the stretched tapes 13 is thus:

$$e = e_1 \times e_2 \times e_3 \times e_4 \times e_5$$

The means provided for heating the intermediate rollers 6 to 10 are not illustrated. They consist preferably of a hot-fluid circulation directed in countercurrent relationship to the tape feed, that is, successively through rollers 10, 9, 8, 7 and 6. Thus, the heat applied to the tapes increases gradually from one intermediate roller to the next roller.

Thus, a considerable tensile strength is imparted to the tapes 13 issuing from the drawing machine.

The overall drawing ratio may range from 8 : 1 to 12 : 1 in the case of polyolefines.

By way of example, a polyolefine tape was treated with the method of this invention;

—Material : polypropylene
—Width of the film at the entry of the machine—720 mm
—Film cut into 72 tapes of 10 mm
—Successive rates of drawing:
—e1 (between rollers 6 and 7 of the drawing) : 2.4
—e2 („ „ 7 „ 8 „ „ „) : 1.7
—e3 („ „ 8 „ 9 „ „) : 1.4
—e4 („ „ 9 „ 10 „ „ „) : 1.3
—e5 („ „ 10 & 11, 12 „ „) : 1.2
—Total drawing:
$e = 2.4 \times 1.7 \times 1.4 \times 1.3 \times 1.2 = 9$
—Thickness before drawing : 0.050 mm
—Thickness after drawing : 0.016 mm
—Width of the tape before drawing : 10 mm
—Width of the tape after drawing : 3.2mm
—Temperature of the cylinders :

The cylinders are heated by a counter-flow oil circuit; first of all the oil arrives in the cylinder No. 10 at a temperature of 145° C, then it passes successively into the cylinders 9, 8, 7 and 6. At the outlet of the cylinder 6, the temperature is 140° C. This means that the material is successively in contact with five intermediate cylinders whose temperature increases from 140 to 145° C.

In this example, the classification of a tape obtained is 430 deniers, and the resistance of the tapes obtained is of 6 grammes per denier.

This very flexible tape is perfectly adequate for the manufacture of textile products, strings and ropes.

Of course, many detail modifications may be brought to the above-described device notably to the number and relative arrangement of the heating intermediate rollers, without departing from the scope of the invention as set forth in the appended claims

WHAT WE CLAIM IS:—

1. Method of drawing synthetic polymer tapes between a series of feed rollers and a series of withdrawal rollers driven at a peripheral velocity higher than that of said feed rollers, the ratio of the peripheral velocities of said feed and withdrawal rollers providing the overall drawing rate and a series of intermediate heating rollers mounted on fixed axes being provided between said feed rollers and said withdrawal rollers, characterized in that said tapes initially at room temperature are caused to pass over said intermediate heating rollers which are brought to a temperature below the softening point of the synthetic polymer to be drawn up to not less than 10° C below this softening point in the case of polyolefines, and that said intermediate rollers are driven at a peripheral velocity increasing gradually from one roller to the next roller in the tape feed direction and lying between that of said feed rollers and that of said withdrawal rollers, the ratio of the peripheral velocities of any pair of adjacent intermediate rollers being selected to be lower than 2 : 1.

2. Method according to claim 1, characterized in that said intermediate rollers are heated to a temperature increasing gradually from one roller to the next roller in order gradually to heat the tapes.

3. Method according to claim 1 or 2, characterized in that said tapes are formed from a film of extruded synthetic polymer cut into longitudinal tapes or strips.

4. Method according to claim 3, characterized in that said extruded film is cut into tapes or strips as it is delivered from said series of feed rollers.

5. Method according to claims 1 to 4, characterized in that said intermediate rollers are disposed in staggered relationship and that said tapes are caused to follow a zig-zag path while contacting said intermediate rollers.

6. Drawn tapes of very reduced thickness, of the order of $\geqslant$0.040 mm, characterized by a marked orientation in the longitudinal direction, obtained by the method disclosed in claims 1 to 5 hereinabove.

7. Apparatus for drawing synthetic polymer tapes according to the method described in claims 1 to 5 hereinabove, which comprises a series of feed rollers and a series of withdrawal rollers, between which is arranged a series of intermediate heating rollers mounted on fixed axes, the peripheral velocity of said withdrawal rollers being greater that that of said feed rollers, characterized in that said intermediate heating rollers are heated at a temperature up to several degrees below the softening point of the synthetic polymer, and in that said intermediate rollers are driven at a peripheral velocity increasing from one roller to the next roller and ranging between the peripheral velocity of the feed rollers and that of the withdrawal rollers, the ratio of the peripheral velocities of two adjacent intermediate rollers being lower than 2 : 1.

8. Apparatus according to claim 7, characterized in that said intermediate rollers have gradually increasing temperatures from one roller to the next one.

9. Apparatus according to claims 7 or 8, characterized in that it comprises a device for cutting a film of synthetic polymer into longitudinal tapes or strips, this device being disposed between said series of feed rollers and the first one of said intermediate rollers.

10. Apparatus according to claims 7 to 9, characterized in that said intermediate rollers are heated by means of internal electrical resistances or a hot fluid circulation.

11. Apparatus according to claims 7 to 10, characterized in that said intermediate rollers are disposed in staggered relationship.

12. Method substantially as described hereinabove with reference to the accompanying drawing.

13. Apparatus substantially as described hereinabove with reference to the accompanying drawing.

14. Tapes obtained by applying the method described hereinabove.

15. Tapes obtained by means of the apparatus described hereinabove.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*